Amendments

Please amend the claims as follows:

1. (currently amended) A method for controlling the rate for encoding a video sequence, wherein the video sequence comprises a plurality of Group Of Pictures, wherein each Group of Picture comprises at least an I-frame and an Inter-frame, the method comprising the following ~~steps~~ for the encoding of each Inter-frame in the Group of Picture:

- Determining a desired frame rate based on an available bandwidth of a channel which is used for transmitting the video sequence and on available computational resources for the encoding process;

- Determining a target buffer level based on the desired frame rate and the position of the Inter-frame with respect to the I-frame; and

- Determining a target bit rate based on the target buffer level and the available channel bandwidth, wherein the target bit rate is used for controlling the rate for encoding the video sequence.

2. (currently amended) The method for rate control according to claim 1, <u>further</u> comprising ~~the further steps of~~:

Determining a target encoding time interval for the Inter-frame; and

Determining the desired frame rate based on the determined target encoding time interval.

3. (Original) The method for rate control according to claim 2, wherein the target encoding time interval for the Inter-frame is determined based on the available channel bandwidth and an average encoding time interval used for encoding the Inter-frame, wherein the average encoding time interval for the Inter-frame is proportional to the available computational resources for the encoding process.

4. (Original) The method for rate control according to claim 3, wherein the target encoding time interval for the Inter-frame is determined using the following equations:

$$T_{fi}(n) = A_1 * T_{fi}(n-1) \quad \text{if} \quad B_{mad}(n) > B_1 * TB_{mad}(n),$$

$$T_{fi}(n) = A_2 * T_{fi}(n-1) \quad \text{if} \quad B_{mad}(n) < B_2 * TB_{mad}(n),$$

$$T_{fi}(n) = T_{fi}(n-1) \quad \text{otherwise,}$$

wherein

$T_{fi}(n)$ is the target encoding time interval for the Inter-frame,

A_1 is a parameter wherein $0.80 < A_1 < 1.00$,

A_2 is a parameter wherein $1.00 < A_2 < 1.10$,

B_1 is a parameter wherein $1.00 < B_1 < 2.00$,

B_2 is a parameter wherein $0 < B_2 < 1.00$,

$TB_{mad}(n)$ is the average of $B_{mad}(n)$, and

$B_{mad}(n)$ is defined as

$$B_{mad}(n) = \frac{u(n)\max\{T_{ave}(n-1), T_{fi}(n-1)\}}{MAD(n)}$$

wherein

u(n) is the available channel bandwidth,

Tave(n-1) is the average encoding time interval for the Inter-frame, and

MAD(n) is the mean absolute difference between the current frame and the previous frame.

5. (Original) The method for rate control according to claim 4, wherein the target encoding time interval is further adjusted by

$$T_{fi}(n) = \min\left\{\frac{5}{4F_r}, \max\left\{\frac{3}{4F_r}, T_{fi}(n)\right\}\right\}.$$

6. (Original) The method for rate control according to claim 3, wherein the average encoding time interval for the Inter-frame is determined based on an actual encoding time interval for the Inter-frame.

7. (Original) The method for rate control according to claim 6, wherein the average encoding time interval for the Inter-frame is further determined based on the target encoding time interval and the number of skipped frames due to buffer overflow.

8. (Original) The method for rate control according to claim 7, wherein the average encoding time interval for the Inter-frame is determined using the following equation:

$$T_{ave}(n) = (1-x)T_{ave}(n-1) + \chi * \max\left\{T_c(n), \frac{1}{F_r} - RT_{st}(n-1)\right\}$$

wherein

χ is a weighting factor,

Tc(n) is the actual encoding time,

Fr is a predefined frame rate, and

RTst is further defined as

$$RT_{st}(n) = 0 \quad \text{if} \quad \max\{T_c(n), T_{fi}(n)\} < \frac{1}{F_r} - RT_{st}(n-1) \text{ or } N_{post}(n) > 0,$$

$$RT_{st}(n) = \{T_c(n), T_{fi}(n)\} + RT_{st}(n-1) - \frac{\left\lfloor (\max\{T_c(n), T_{fi}(n)\} + RT_{st}(n-1))F_r \right\rfloor}{F_r}$$

otherwise,

wherein $N_{post}(n)$ is the number of skipped frames due to buffer overflow.

9. (Original) The method for rate control according to claim 5, wherein the target buffer level is determined such that an Inter-frame which is nearer to the I-frame in the GOP has a higher target buffer level compared to another Inter-frame which is further from the I-frame belonging to the same GOP.

10. (Original) The method for rate control according to claim 9, wherein the target buffer level is determined using the following equation:

$$Target(n) = Target(n-1) - \frac{B_c(t_{i,l}) - \delta * B_s}{N_{gop} - 1} * \sum_{j=0}^{N_{post}(n-1)+S_c(n-1)} W_{pos}(n+j)$$

wherein

Target(n) is the target buffer level,

Ngop is the number of frames in a GOP,

Bs is the buffer size,

Bc is the actual buffer occupancy,

Sc is an average number of skipped frames due to insufficient available computational resources for encoding the Inter-frame according to the desired frame rate, and

$W_{pos}(l)$ is the position weight of the l^{th} Inter-frame which satisfies

$$\sum_{l=1}^{N_{gop}-1} W_{pos}(l) = N_{gop} - 1$$

and

$$W_{pos}(1) \le W_{pos}(2) \le \cdots \le W_{pos}(N_{gop} - 1).$$

11. (Original) The method for rate control according to claim 10, wherein the average number of skipped frames due to insufficient available computational resources for encoding the Inter-frame according to the desired frame rate is determined

based on an instant number of skipped frames due to the insufficient computational resources while encoding the Inter-frame.

12. (Original) The method for rate control according to claim 11, wherein the instant number of skipped frames due to insufficient computational resources is determined based on the actual encoding time interval and the target encoding time interval.

13. (Original) The method for rate control according to claim 12, wherein the instant number of skipped frames is determined using the following equation:

$$\tilde{S}_c(n) = \lfloor TST(n) * F_r \rfloor$$

wherein TST(n) is further defined as

$$TST(n) = \max\left\{0, \tilde{\tilde{T}}\tilde{S}\tilde{T}(n-1) + \max\left\{T_c(n), T_{fi}(n)\right\} - \frac{1}{F_r}\right\}$$

and $\tilde{\tilde{T}}\tilde{S}\tilde{T}(n-1)$ is defined as

$$\tilde{\tilde{T}}\tilde{S}\tilde{T}(n-1) = TST(n-1) - \frac{\lfloor TST(n-1) * F_r \rfloor}{F_r}$$

wherein

$\tilde{S}_c(n)$ is the instant number of skipped frames due to insufficient computational resources,

Tc(n) is the actual encoding time interval, and

Fr is a predefined frame rate.

14. (Original) The method for rate control according to claim 13, wherein the average number of skipped frames due to insufficient computational resources is determined using the following equation:

$$S_c(n) = \left\lfloor (1-\theta) S_c(n-1) + \theta * \tilde{S}_c(n) \right\rfloor$$

wherein

θ is a weighting factor.

15. (Original) The method for rate control according to claim 14, wherein the target bit rate is determined based on the average encoding time interval for the Inter-frame, the average number of skipped frames due to insufficient computational resources, the target buffer level, the available channel bandwidth and actual buffer occupancy.

16. (currently amended) The method for rate control according to ~~claims 8 and 15~~ claim 8, wherein the target bit rate is determined using the following equation:

$$\tilde{f}(n) = \max\left\{0, u(t_{n,i}) * \max\left\{T_{ave}(n-1), T_{fi}(n)\right\} + (\gamma - 1)\left(B_c(t_{n,i}) - T\arg et(n)\right)\right\}$$

wherein

$\tilde{f}(n)$ is the target bit rate,

tn,i is the time instant the nth Inter-frame in the ith GOP is coded, and

γ is a constant.

17. (Original) The method for rate control according to claim 16, wherein the target bit rate is further adjusted by a weighted temporal smoothing using

$$f(n) = \max\left\{\frac{u(t_{n,i}) * \max\left\{T_{ave}(n-1), T_{f,i}(n)\right\}}{3} + H_{hdr}(n-1), \mu \times \tilde{f}(n) + (1-\mu) \times f(n-1)\right\}$$

wherein

f(n) is the smoothed target bit rate,

μ is a weighting control factor constant, and

Hhdr(n) is the amount of bits used for shape information, motion vector and header of previous frame.

18. (currently amended) The method for rate control according to claim 1, further comprising ~~the following steps~~:

Determining a sleeping time of each frame after the frame is coded,

Determining a starting encoding time of each of the frame based on the computed sleeping time,

Determining a starting decoding time of a next frame based on the computed starting encoding time, and

Transmitting the determined starting decoding time to a decoder which is designed for decoding the video sequences.

19. (Original) The method for rate control according to claim 18, wherein the sleeping time is determined according to the following formula:

$$ST_c(n) = \max\left\{\frac{1}{F_r} - RT_{st}(n-1) - \max\{T_{fi}(n), T_c(n)\}, 0\right\} + \frac{N_{post}(n)}{F_r}$$

wherein $ST_c(n)$ is the sleeping time of the coding process.

20. (Original) The method for rate control according to claim 19, wherein the starting encoding time is determined according to the following formula:

$$SCT(n) = T_c(n) + SCT(n-1) + ST_c(n)$$

wherein SCT(n) is the starting encoding time.

21. (Original) The method for rate control according to claim 20, wherein the starting decoding time is determined according to the following formula:

$$SDT(n) = \frac{\lfloor SCT(n) * F_r \rfloor}{F_r}$$

wherein SDT(n) is the starting decoding time.

22. (Original) An apparatus for controlling the rate for encoding a video sequence, wherein the video sequence comprises a plurality of Group Of Pictures, wherein each Group of Picture

comprises at least and I-frame and an Inter-frame, the apparatus comprises a processing unit being adapted to perform the following steps for the encoding of each Inter-frame in the Group of Picture:

Determining a desired frame rate based on an available bandwidth of a channel which is used for transmitting the video sequence and on available computational resources for the encoding process;

Determining a target buffer level based on the desired frame rate and the position of the Inter-frame with respect to the I-frame; and

Determining a target bit rate based on the target buffer level and the available channel bandwidth, wherein the target bit rate is used for controlling the rate for encoding the video sequence.

23. (Original) A video encoding device for controlling the rate for encoding a video sequence, wherein the video sequence comprises a plurality of Group Of Pictures, wherein each Group of Picture comprises at least and I-frame and an Inter-frame, the encoding device comprises a processing unit being adapted to perform the following steps for the encoding of each Inter-frame in the Group of Picture:

Determining a desired frame rate based on an available bandwidth of a channel which is used for transmitting the video sequence and on available computational resources for the encoding process;

Determining a target buffer level based on the desired frame rate and the complexity and the position of the Inter-frame with respect to the I-frame; and

Determining a target bit rate based on the target buffer level and the available channel bandwidth, wherein the target bit rate is used for controlling the rate for encoding the video sequence.